Fishery Data Series No. 96-44

Evaluation of Stocked Game Fish in the Tanana Valley, 1995

by

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and

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November 1996

Alaska Department of Fish and Game Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd
Spell out acre and ton.	

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s
Spell out year, month, and week.	

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$log_{2,}$ etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

Evaluation of visual implant tags as marks to distinguish individual rainbow trout *Oncorhynchus mykiss*, estimation of reproduction by Arctic char *Salvelinus alpinus* in Harding Lake, and analysis of the cost effectiveness of the stocking program in the Tanana Valley are described. Visual implant tags were judged unacceptable as marks when within 72 days, 117 of 323 hatchery-held fish had shed their tags while tags in another 31 fish became unreadable. Sampling in Harding Lake was suspended halfway through the study when no juvenile Arctic char had been captured in gill nets, and incidentally caught lake trout *S. namaycush* and northern pike *Esox lucius* were dying at high rates. Of the major stocked fisheries with management plans in 1994, objectives for cost-per-angler day was met only at Quartz Lake. Cost-per-angler-day averaged $5.12 that year across the program. Objectives for harvest rates were not met anywhere in 1994, and stocked fisheries at small lakes (as a unit) was the only component of the program that drew enough fishing effort to meet its objective for 1994. Cost-per-angler-day was lower in 1994 than in 1993. Over both 1993 and 1994 together, Arctic grayling *Thymallus arcticus* proved the cheapest species to stock ($0.34 apiece) and Arctic char the most expensive ($14.94 apiece).

Key words: Birch Lake, Chena Lake, Quartz Lake, Harding Lake, stocking evaluation, Arctic char, *Salvelinus alpinus*, rainbow trout, *Oncorhynchus mykiss*, Arctic grayling, *Thymallus arcticus*, northern pike, *Esox lucius*, burbot, *Lota lota*, least cisco, *Coregonus sardinella*, lake trout, *Salvelinus namaycush*, kokanee, *Oncorhynchus nerka*, chinook salmon *Oncorhynchus tshawytscha*, catch per unit effort, growth, cost-per-day of fishing, stocking cost, days fished, fishing effort, cost-to-the-creel, cost/benefit, visual implant tag, tag loss.

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) stocks game fish in numerous lakes and one stream in the Tanana River Valley (a portion of interior Alaska; Figure 1) to provide more angling opportunities near population centers and offer alternatives to the harvest of wild stocks. The stocking program began in the early 1950's, when lakes along the road system were stocked with rainbow trout *Oncorhynchus mykiss*, or coho salmon *O. kisutch*. Today, the stocking program provides diverse year-round sport fishing for rainbow trout coho salmon, chinook salmon *O. tshawytscha*, Arctic grayling *Thymallus arcticus*, Arctic char *Salvelinus alpinus*, and lake trout *S. namaycush*.

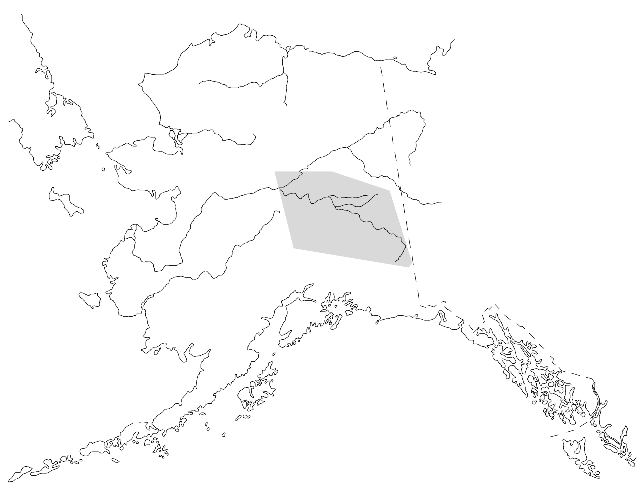

Figure 1.-The Tanana Valley (shaded area).

The stocking program provides consumptive fisheries along the road system where fishing effort and consumptive harvests are highest. In 1994, an estimated 32,334 anglers fished in the Tanana

Valley and they generated an estimated 148,633 angler-days of effort[1] (Howe, et al. 1995), second only to the Kenai Peninsula for number of angler-days. Populations of wild fish along the road system can not support these harvest levels. Since 1991 stocked fish represent 51 to 69% of the estimated harvest of game fish in the Tanana Valley and about 38 to 49% of the total estimated fishing effort. In estimates from 1994, more than three times as many anglers (25,089) participated in fisheries maintained through stocking compared to anglers (7,245) who fished on wild populations (Table 1). However, an average of about two fishing trips were made by anglers who fished stocked populations compared to an average of almost 10 trips made by anglers who fished wild populations. During 1994, an estimated 45% of the total harvest of wild and stocked fish in the Tanana Valley was attributed to just two stocked species; rainbow trout and landlocked coho salmon (Mills 1994).

In 1991, ADF&G significantly changed species, numbers, and sizes of game fish stocked in the Tanana Valley. These changes were based on a review of fishery studies, angler surveys, and creel surveys conducted since the 1970's. Concurrent with these changes, ADF&G developed Fishery Management Plans (FMP) for fisheries at Birch, Quartz, Chena, and Harding lakes, Piledriver Slough, and across an aggregation of more than 80 small lakes (ADF&G 1993). The FMPs list objectives that provide for minimum mean annual mean catch rates, limit stocking costs and serve to guide and evaluate the stocking program.

Table 1.-Comparison of estimated angler participation in fisheries based on stocked and wild fish populations in the Tanana Valley, 1994.

Type of Fish Population	Number of Anglers	Number of Trips	Effort (days fished)
Stocked	25,089	46,976	56,739[a]
Wild	7,245	71,076	91,894
Entire Tanana Valley (Stocked and Wild)	32,334	118,052	148,633

[a] Data for the entire Tanana Valley were obtained from Howe, et al. (1995). These data were then apportioned to the appropriate type of population (stocked or wild) based on the proportion of the entire effort that was directed to stocked (0.38) or wild (0.62) populations.

In 1994, in response to a request from anglers, ADF&G identified three lakes (Craig Lake, Coalmine #5 Lake, and Little Harding Lake) where we would establish a fishery for trophy size rainbow trout. Trophy size was defined as 18 inches (457 mm) or longer. To accomplish this objective, we developed a special management plan and modified the stocking program. The Alaska Board of Fisheries established special regulations for these three fisheries.

In 1995 we initiated an investigation to determine if Arctic char were reproducing in Harding Lake. If Arctic char are producing significant numbers of offspring then we can reduce the number of Arctic char stocked in Harding Lake and stock the surplus fish in other lakes.

[1] Fishing effort (angler-days) for a location is defined as the estimated number of days fished by all anglers for that location (Mills 1980-1994, and Howe, et al. 1995). Any part day fished by an angler is considered one whole day or one angler-day.

The studies summarized in this report are intended to provide fishery managers with information to assess how well ADF&G is progressing toward achieving the objectives in the management plans for the major fisheries and for special fisheries such as those for trophy rainbow trout.

Following are the objectives of studies conducted to monitor the stocking program, Project F-10-11, Job E-3-1(a).

1. Estimate the rate that visual implant tags (VITs) are lost from fish that are tagged and kept in a hatchery.
2. For the Arctic char population in Harding Lake, test the hypothesis that the CPUE of Arctic char from natural reproduction during the fall of 1993 is equal to one fourth the CPUE of the Arctic char that were stocked in the fall of 1994.

In addition, we evaluated cost-per-day of fishing as progress toward achieving the management objectives for fisheries at Birch, Quartz, and Chena lakes.

TROPHY RAINBOW TROUT

Success in establishing fisheries for trophy rainbow trout in Little Harding Lake, Craig Lake, and Coal Mine #5 Lake have criteria based on growth. For these fisheries to be considered successes, at least half of an age cohort must exceed 14 inches (356 mm) by the end of the third summer after stocking (age 4). When stocked these fish are age 1 and at least 20 g. We used visual implant tags (VITs) to unobtrusively mark fish. The visual implant tags and the tag injector were manufactured by Northwest Marine Technology, Inc. WA. The tag injector is described as a portable, hand powered, semiautomatic visible implant (VI) injector. The tags are standard size (1.0 mm wide by 2.5 mm long). Each tag had a unique 3-digit alpha numeric code. The purpose of this study was to assess the loss of VITs inserted in 60 g rainbow trout.

METHODS

About 400 rainbow trout were removed from a raceway at the Fort Richardson Fish Hatchery and transferred to a circular tank. The average weight of the fish in the raceway was an estimated 60 g. Ten to 20 fish at a time were removed from the circular tank and anesthetized with tricane-methylsulfanate (MS222). Individually, the fish were marked by injecting a VIT and removing the adipose fin. After being marked, each fish was measured to the nearest millimeter fork length (FL). We inserted the VIT at the upper margin of the postorbital adipose tissue with the long axis of the tag oriented dorsal-ventral. If we tore the adipose tissue on the left while trying to insert the VIT, we then tried to insert the VIT on the right. If the adipose tissue was torn on both sides, the fish was not used in this study. Marked fish were held in a circular tank for the duration of the study.

Fish were marked in two batches on 28 and 29 March 1995 and were examined for tags after 24 hours, 14 days, 43 days and, 72 days. After 30 March, both batches were treated as if they had been marked on 28 March for the purpose of calculating intervals. When we examined fish for VITs, we also noted any factors (such as the formation of pigmented spots) that made it difficult for us to read the tag. Mortalities were not examined for VITs.

RESULTS

Three hundred twenty three fish were initially marked with VITs and fin clips (Table 2). Overall, 117 tags were lost and 25 fish died during 72 days of the study. When we examined the fish on 11 April we found one tag was not readable because a white cloudy area had formed around the tag. We lanced and applied pressure to the area to force out a pus-like substance. We were then able to read the tag. On 10 May we found 11 more fish had developed a cloudy area and two fish had pigmented spots which made reading VITs difficult. During the last check, 8 June, we found 17 fish had developed cloudy areas and another three fish had formed silver pigment over the tags. We either lanced the cloudy areas or used a scalpel to scrape away the dark or silver pigment so we could read the tags.

Table 2.-Summary of loss of visible implant tags (VITs) from 24 hours to 72 days after implant (28 March through 8 June 1995).

	Days After VIT Implant						
	Mark	24 hrs	Mark	24 hrs	14	43	72
Date	28-Mar	29-Mar	29-Mar	30-Mar	11-Apr	10-May	8-Jun
Number Marked	243		80				
Mortalities		4		0	2	4	15
Fish without tags		20		0	36	33	28
Fish with tags		219		299	261	224	181

DISCUSSION

We had anticipated that tag loss would eventually decrease until no further tags were lost. However, during this study we did not see any evidence that tag loss would halt. Kincaid and Calkins (1992) found that tag loss was highest among yearling Atlantic salmon *Salmo salar* during the first 70 days and occurred primarily through the insertion wound. "After 70 days healing was complete and tag loss thereafter resulted from erosion through the postorbital adipose tissue." Our study ended at about the time the wounds should have healed. If our study had lasted longer we may have seen a decrease in the rate of tag loss. Kincaid and Calkins reported tag loss after 294 days was 29% for Atlantic salmon weighing 41-99 g. This was much less than what we observed. They did not handle their fish during the first 39 days after marking to allow the insertion wounds to heal. The higher tag loss we found could be due to handling before the insertion wounds healed. Evidence from our study, along with Kincaid and Calkins, and Frenette and Bryant (USDA-Forest Service, Juneau, Alaska, personal communication), and Blankenship and Tipping (Washington Department of Fisheries, Olympia, Washington, personal communication) imply that tag loss is highly variable (0 to 100%) and seems to be related to species and size when tagged, the experience of the personnel doing the tagging, and improvements made to the tags and tagging gun to increase retention. This was our first try at tagging fish with VITs which may account for high tag loss.

In another study, workers at the Fort Richardson Fish Hatchery also found that the ability to read VITs in some fish was greatly reduced by the formation of pigmented spots or the development of a cloudy white area (G. Wall, Fort Richardson Fish Hatchery, Fort Richardson, Alaska, personal communication). Kincaid and Calkins attributed a cloudy black area that developed around the VIT in their fish to an immune response to the tag. Most of the mortalities during our study happened because fish jumped out of the circular tank and probably were not directly related to any injury from handling during marking.

We had planned to use VITs to identify cohorts of rainbow trout and to conduct capture-recapture experiments to estimate abundance. Because tag loss was too high and tag loss continued for the duration of our study, we will not use VITs as planned. However, individuals that retain VITs will allow us to monitor growth of these fish.

ARCTIC CHAR REPRODUCTION IN HARDING LAKE

The purpose of this project was to determine if stocked Arctic char have produced offspring. During population studies in Harding Lake a few captured Arctic char were found to have retained and/or developing eggs.

All Arctic char stocked in 1994 were marked with adipose fin clips to distinguish them from Arctic char that may have been produced from fish stocked in prior years. The average weight of Arctic char stocked in 1993 were 106 g (about 200 mm) and in 1994 were 59 g (about 170 mm). Fish stocked in 1993 were not marked. We attempted to catch juvenile Arctic char (<300) from

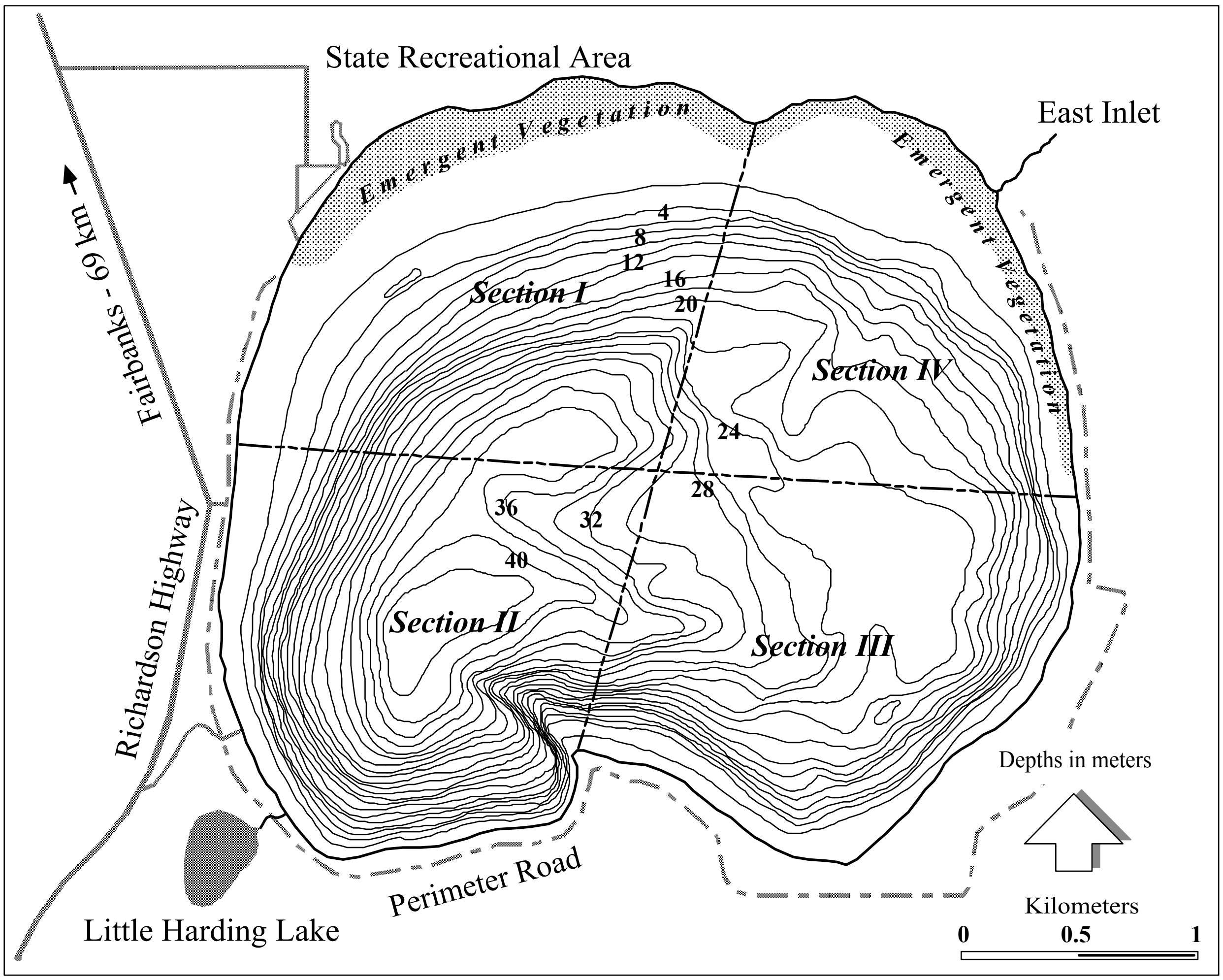

Figure 2.-Harding Lake.

24 July through 28 July 1995. We used monofilament sinking gillnets 30 m long by 2.4 m deep with 12.7 mm stretched bar measure. The lake was divided into quadrants (Figure 2) and four depth zones for sampling: 0 to 9 m, >9 to 18 m, >18 to 27 m, and >27 m. Depth zones were measured from surface to bottom and one depth zone did not overlay another. Nets were fished on the bottom. One sampling event involved fishing one net per quadrant for about 24-hours. The depth zone fished within each quadrant was randomly selected without replacement. Sampling the entire lake was completed in four sampling events.

No juvenile Arctic char were captured in four sampling events. Other Arctic char and non target species captured during sampling are summarized in Tables 3 and 4. We do know that juvenile Arctic char are present because they have been stocked for a number of years (Appendix A). However, our results indicate that the abundance of juvenile Arctic char (from stocking and natural reproduction) is too low to detect with our level of sampling effort (number of nets used and number of days the nets were fished). Mesh size for the gillnets was appropriate because we have captured various species larger and smaller than the target size for Arctic char. During earlier studies at Harding Lake, juvenile Arctic char were captured using similar methods (Viavant and Clark, 1991; Doxey 1991; Skaugstad *et al* 1994). However, a review of these studies suggests these fish were likely stocked within a few weeks of sampling. Our sampling was scheduled about one month prior to stocking to avoid catching newly stocked fish.

Table 3.-Catch by species and quadrant in Harding Lake, 25-28 July 1995.

Date	Quadrant	Northern Pike	Arctic Char	Lake Trout	Least Cisco
25 Jul 95	1	0	1	5	6
	2	0	1	1	1
	3	0	2	2	0
	4	0	1	2	0
26 Jul 95	1	0	0	1	0
	2	1	0	1	2
	3	0	1	0	0
	4	0	2	1	0
27 Jul 95	1	0	1	1	1
	2	0	0	0	1
	3	0	0	1	1
	4	0	1	1	0
28 Jul 95	1	0	1	2	1
	2	0	1	1	0
	3	0	0	1	1
	4	0	0	0	0
	Total	1	12	20	14

We stopped sampling after four events because we had captured no juvenile Arctic char, but, had killed four (453-690 mm FL) of 12 Arctic char and five (385-540 mm FL) of 20 lake trout. These larger fish are valued by anglers. Continued sampling with gillnets would probably result in killing additional large game fish. We decided to investigate other methods to capture juvenile Arctic char that will not kill large game fish.

Table 4.-Length (mm) of fish captured and depth zone (DZ) where fish were captured in Harding Lake, 25-28 July 1995.

Northern Pike Fork		Arctic Char Fork		Lake Trout Fork		Least Cisco Fork		Burbot Total	
Length	DZ	Length	DZ	Length	DZ	Length	DZ	Length	DZ
695	2	356	4	385	3	118	2	564	2
		453	2	394	2	119	2	760	2
		500	4	402	2	122	2		
		531	3	415	4	127	2		
		552	2	431	2	128	2		
		572	2	440	2	130	2		
		573	2	454	2	133	2		
		625	2	458	2	134	2		
		630	2	459	3	136	2		
		646	2	495	2	142	4		
		690	3	505	2	183	3		
		732	2	515	3	203	3		
				540	2	234	3		
				550	2	245	3		
				561	2				
				578	2				
				752	4				
				865	4				
				865	3				
				920	2				

DZ = depth zones were: 1 = 0 to 9 m; 2 = >9 to 18 m; 3 = >18 to 27 m; and, 4 = >27 m.

ASSESSMENT OF FISHERY MANAGEMENT OBJECTIVES FOR STOCKED WATERS

Over the years we have modified our stocking program for our major fisheries (Table 5) to adapt to changing fisheries, modifications to hatcheries, and to take advantage of new research. We have found the lowest cost-to-a-catchable fish was dependent on the size of fish used for stocking and the best size was different for each lake. For example, fingerling[2] (1-10g) rainbow trout stocked in Quartz Lake produce the lowest cost-to-a-catchable fish while stocking subcatchable (15-75g) rainbow trout in Birch Lake give the lowest cost. In Chena Lake we stock catchable (>90g) rainbow trout because growth and survival rates are low for fish stocked as fingerlings or subcatchables. To reduce stocking costs but maintain fishing effort in Piledriver Slough, ADF&G decreased the number of rainbow trout that are stocked but increased their size. Harding Lake received a major portion of the fish produced for the stocking program from 1989 through 1992 but yielded only a low level of effort. As a result, to make the stocking program more efficient, the number of game fish stocked in Harding Lake was greatly reduced. To provide more fishing opportunities we are emphasizing small lakes in urban areas with easy road access. We have diverted more resources toward these lakes by stocking more fish and/or larger fish, and providing additional promotion through informational handouts to anglers and news releases.

Table 5.-Estimated number of days fished by location in the Tanana Valley, 1994.

Location	Effort (days fished)
Birch Lake	9,880
Quartz Lake	14,031
Chena Lake	2,828
Harding Lake	4,913
Piledriver Slough	11,369
Small Lakes[a]	21,859

[a] Calculated using methods described in this report.

In 1995 we started stocking catchable sized fish in early spring in lakes with popular fisheries. Prior to altering our stocking strategy, anglers were expressing frustration with these fisheries because by spring there were too few large fish. Most of the catchable fish had been harvested by winter. We still stock catchable fish in late spring/early summer as we have done in the past to provide catchable fish for the remaining season. Because our hatcheries have expanded their capacity to produce catchable fish, we now stock lakes which can not produce or sustain sufficient numbers of large fish to support a desirable fishery. In these lakes we stock only what we anticipate will be harvested. This stocking strategy increases the number of lakes that we can stock and provides new fisheries in urban areas where potential use is high.

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[2] The weight intervals that are used for classifying fish as fingerling, subcatchable, or catchable are arbitrary. Generally, fish stocked as fingerlings do not reach catchable size (about 90g) until the second year after stocking and most fish stocked as subcatchables reach catchable size one year after stocking.

METHODS

Assessment of the management objectives for each fishery requires the collation of data from several sources. Fishery management objectives were obtained from Fishery Management Plans (FMPs) for Piledriver Slough, and Birch, Quartz, Chena, Harding, and the Small lakes (ADF&G 1993). Fish production and its cost for 1995 were obtained from audits of hatchery records. Prior to 1995, costs and production data were obtained from the Recreational Fishery Program Maintenance of Effort report (CFMD 1984-1994). Hatchery operating costs are based on a fiscal year that begins 1 July and ends 30 June (i.e., FY94 is for the period 1 July 1993 through 30 July 1994) while stockings are scheduled on a calendar year (CY). Hatchery production is the total weight of fish stocked from 1 January through 31 December. Costs and production include all costs and all production for the hatchery, even though some portion of the fish were not destined for release in the Tanana Valley, were for commercial fisheries, or were used for the rehabilitation of the Arctic grayling population in the Chena River. Estimates of the number of anglers, the fishing effort (angler days) and the total harvest of game fish by species for each lake and Piledriver Slough were obtained from the Statewide Harvest Survey (SWHS; Mills 1980-1994, Howe, et al. 1995). Some of these data required further manipulation to allocate effort between stocked and wild fish populations for certain locations, to calculate stocking costs by location and species, and to calculate cost-per-day-fished (CDF).

Stocking costs for calendar year 1994 (CY94) were based on operating costs for FY94 and fish production for CY94. We obtained estimates of average weight and number of fish for each released cohort from the Ft. Richardson and Clear AFB hatcheries. Stocking costs for individual cohorts were then summed by location and species.

We calculated stocking costs for each cohort and cost-per-day of fishing (CDF),

$$\hat{c}_i = \frac{C}{\hat{W}}(\hat{n}_i \hat{\bar{w}}_i) \tag{1}$$

$$\widehat{CDF} = \frac{\sum \hat{c}_i}{\hat{E}} \tag{2}$$

where:

C	=	hatchery operating cost in a fiscal year;
W	=	weight of fish stocked in a calendar year;
n_i	=	number of fish stocked in cohort *i*;
$\bar{w}_i$	=	average weight of fish stocked in cohort *i*,
c_i	=	cost of fish stocked in cohort *i*,
E	=	total annual angler days of fishing effort by location; and,
CDF	=	cost per angler day by location.

We defined a cohort as a group of similar size fish of the same species and age that were stocked at the same time in the same location. For example: a cohort of 4 g rainbow trout that was stocked in 1991 was considered different from a cohort of 24 g rainbow trout that was stocked in 1991. Both of these cohorts are different from a cohort of 4 g rainbow trout that was stocked in 1992. Annual cost for a stocking location was calculated as the sum of all costs associated with stocking fish for that location. We used similar methods to calculate the total annual stocking costs by species. Estimates of fishing effort were obtained with some modification from the SWHS for fisheries at Harding Lake, Piledriver Slough, and small lakes. For Harding Lake and Piledriver Slough, estimates of fishing effort were arbitrarily divided by two because these locations have populations of wild game fish. There are no wild fish in the other major lakes (Birch, Quartz, and Chena). Some of the small lakes were listed individually in the SWHS and effort was estimated for each lake. However, due to small sample sizes, most of the small lakes were grouped and a single estimate of effort was made for the group. Within this group of small lakes is another group called "other lakes". Some of these "other lakes" have stocked game fish, others have only wild fish, and some have both. Because wild fish made a significant contribution to the harvest for these fisheries, the effort for these "other lakes" was apportioned using the proportion of stocked and wild fish that were harvested from these lakes (Table 6). All rainbow trout, coho salmon, chinook salmon, Arctic char, and Arctic grayling were considered to have come from stocked populations. Fish that were listed as either Arctic char or Dolly Varden in the SWHS were considered to be Arctic char because only a few lakes in the Tanana Valley have wild Dolly Varden. All other harvested fish were considered wild.

Table 6.-Portion of total effort attributed to game fish stocked in Tanana Valley lakes that were classified as "other lakes" in the Alaska Statewide Harvest Survey.

	Number of Days Fished (effort)			
Year	All Small Lakes	"Other Lakes"	Adjustment Factor[a]	Adjusted effort
1986	3,978	719	0.49	3,612
1987	8,777	887	0.65	8,466
1988	16,189	1,346	0.61	15,662
1989	15,432	1,564	0.63	14,854
1990	16,479	3,663	0.51	14,686
1991	16,758	1,185	0.74	16,449
1992	10,578	NA[b]		
1993	23,950	3,576	0.60	22,516
1994	23,483	1,089	0.59	21,859

[a] The adjustment factor for effort was calculated from the harvest data for "Other Lakes". The adjustment factor for effort is the proportion for the number of stocked fish harvested from "Other Lakes" divided by the total number of fish harvested (stocked and wild) from "Other Lakes". The adjusted effort was calculated using:

$$\left(\text{All Small Lakes} - \text{"Other Lakes"}\right) + \text{"Other Lakes"} \times \text{Adjustment Factor}$$

[b] The number of days fished at "Other Lakes" in 1992 was not available for this report.

Cost/benefit for each species was calculated by dividing the stocking cost by the sum of the harvest and catch from Mills (1994) and Howe, et al. (1995).

RESULTS

Management objectives from the FMPs are summarized in Table 7 along with the actual fishery statistics for 1992-94. Generally, effort, harvest, and mean harvest rate for all fisheries were less in 1994 than in 1993. Only the Small Lakes exceeded the objective for effort in 1994 (higher values are better). Management objectives for mean harvest rate were not achieved for any location in 1994 (higher values are better). Stocking cost and CDF were less in 1994 than in 1993 for all but Chena Lake (lower values are better). Quartz Lake was the only location in 1994 for which the CDF was less than the objective (lower values are better). Historical statistics since 1977 for effort, harvest, and stocking costs are summarized in Appendix B. Operational costs, fish production, and costs per kilogram since 1986 are summarized in Appendix C. Costs of fish stocked from 1986 through 1995 are summarized for each major location in Appendix D.

Most money was spent producing rainbow trout; the most expensive fishing day was a day at Chena Lake; and stocking Arctic grayling provided the best benefit for dollar spent. The breakdown of stocking costs by species for 1994 and 1995 were: rainbow trout - $142,087 and $274,192; Arctic grayling - $16,460 and $33,989; Arctic char - $72,128 and $124,756; coho salmon - $23,142 and $120,027; chinook salmon - $21,850 and $50,475; and, lake trout - $14,835 and $0 (none were stocked in 1995). The average CDF for CY94 was $5.12 for all locations in the Tanana Valley with populations of stocked fish (Table 8). By location, the CDFs were: Birch Lake - $5.34; Quartz Lake - $2.07; Chena Lake - $13.35; Piledriver Slough - $7.56; Harding Lake - $6.33; and, Small Lakes - $5.14. These values do not include fishing effort attributed to populations of wild fish. For CY93 and CY94 the cost/benefit for the various species stocked in the Tanana drainage ranged from $0.34 for Arctic grayling to $14.94 for Dolly Varden/Arctic char (Table 9). The two year average cost/benefit by species were: Arctic grayling - $0.41, rainbow trout - $1.11, coho and chinook salmon - $1.62, lake trout - $2.25, Dolly Varden and Arctic char - $13.94. The overall two year average cost/benefit for all species combined was $1.56. The cost of fish stocked from 1986 through 1995 are summarized by species in Appendix D.

DISCUSSION

Costs and the Number of Days Fished

The method we used to calculate CDF oversimplified the relation between stocking costs, cohort contribution, and effort. We attributed stocking costs to the year that a cohort of fish was stocked; but, the fish usually do not significantly contribute to a fishery until at least one year after stocking. The time between stocking and when a cohort of fish make a significant contribution to the fishery depends on the size of the fish and when they were stocked. The CDF calculated for any year was based on the stocking cost and effort for that year. However, the fish that may have attracted anglers to the fishery and the fish that were harvested probably were from stockings made in prior years.

We also realize that the number of angler days for a location was not entirely dependent on stocking methods, stocking costs, or the quality of the fishery. Stocking methods were designed to maintain acceptable stocking costs while creating fisheries that were acceptable to anglers. Even for an acceptable fishery, weather and major events may affect anglers and their decision to participate in fisheries. Given this situation, effort will most likely fluctuate with environmental and social conditions regardless of the quality of the fishery. This tenuous relationship between

Table 7.-Objectives from Fishery Management Plans and statistics from major fisheries in 1992, 1993, and 1994.

Management Plan	Objective	1992[a]	1993	1994
Birch Lake:				
Days fished	15,000	10,072	10,447	9,880
Harvest		12,855	15,373	10,781
Mean harvest rate	2	1.28	1.47	1.09
Stocking cost		$42,456	$70,368	$52,777
Cost-per-day of fishing	$2.00	$4.22	$6.73	$5.34
Quartz Lake:				
Days fished	20,000	13,486	17,613	14,031
Harvest		20,597	27,676	17,262
Mean harvest rate	2	1.53	1.57	1.23
Stocking cost		$32,025	$45,706	$29,026
Cost-per-day of fishing	$2.50	$2.37	$2.60	$2.07
Chena Lake:				
Days fished	10,000	6,007	6,668	2,828
Harvest		5,829	7,629	3,915
Mean harvest rate	2	0.97	1.14	1.38
Stocking cost		$63,045	$60,480	$37,755
Cost-per-day of fishing	$2.00	$10.50	$9.07	$13.35
Piledriver Slough:				
Days fished	20,000[b]	6,804	8,627	5,685
Harvest[c]		5,454	6,007	2,673
Mean harvest rate	2[d]	0.80	0.70	0.47
Stocking cost		$67,634	$91,726	$42,985
Cost-per-day of fishing	$2.00	$9.94	$10.63	$7.56

-continued-

Table 7.-Page 2 of 2.

Management Plan	Objective	1992[a]	1993	1994
Small Lakes:				
Days fished[e]	20,000	10,794	22,516	21,859
Harvest[f]		6,579	22,557	15,141
Mean harvest rate		0.61	1.00	0.69
Stocking cost		$129,572	$213,291	$114,574
Cost-per-day of fishing	$3.00	$12.00	$9.47	$5.24
Harding Lake:				
Days fished[g]		2,534	2,443	2,457
Harvest[h]		2,085	586	152
Mean harvest rate		0.82	0.24	0.06
Stocking cost		$270,491	$29,937	$15,555
Cost-per-day of fishing	$3.00	$106.74	$12.25	$6.33

[a] 1992 data were re-calculated using updated information.

[b] The goal for effort in management plan is 40,000 angler-days, however, only one-half of the goal is attributed to stocked rainbow trout.

[c] Piledriver Slough has wild Arctic grayling and stocked rainbow trout. The reported harvest numbers are for rainbow trout only.

[d] Mean harvest rate includes Arctic grayling.

[e] Some of these lakes have wild and stocked fish populations. Reported effort was adjusted to account for stocked fish only.

[f] Reported harvest is for stocked fish only.

[g] Only one-half the estimated effort from the SWHS was attributed to fish that were stocked into Harding Lake.

[h] Reported harvest is for stocked fish only.

Table 8.-Cost-per-day-fished by location in the Tanana Valley, 1986-1995.

Location	1986	1987	1988	1989	1990	1991	1992	1993	1994
Birch Lake	$7.63	$2.71	$5.13	$2.45	$2.54	$1.92	$4.22	$6.74	$5.34
Quartz Lake	$2.70	$4.18	$4.91	$3.10	$2.15	$3.82	$2.37	$2.59	$2.07
Chena Lake	$6.14	$3.45	$6.07	$3.39	$3.66	$11.12	$10.50	$9.07	$13.35
Piledriver Slough		$5.32	$5.67	$3.98	$2.44	$4.86	$12.62	$12.20	$7.56
Harding Lake	$137.52	$83.83	$91.35	$147.54	$182.92	$109.63	$106.74	$12.26	$6.33
Small Lakes	$6.32	$5.99	$3.67	$3.78	$0.41	$3.72	$12.04	$9.06	$5.14
Total	$6.61	$5.73	$5.93	$5.64	$6.68	$8.66	$12.55	$7.55	$5.12

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Table 9.-Cost/benefit for species stocked in the Tanana drainage in 1993 and 1994.

Year	Arctic Grayling	Coho and Chinook Salmon	Rainbow Trout	Dolly Varden and Arctic Char	Lake Trout[a]	Total
1993						
Harvest	2,722	15,734	49,693	3,505	789	72,443
Catch	61,528	31,017	144,699	9,737	2,987	249,968
Stocking Cost	$21,843	$85,411	$210,637	$197,893	$0	$515,784
Cost/Benefit	**$0.34**	**$1.83**	**$1.08**	**$14.94**	**$0.00**	**$1.60**
1994						
Harvest	3,810	10,404	33,249	1,590	817	49,870
Catch	25,633	23,379	90,254	4,540	2,009	145,815
Stocking Cost	$16,460	$44,992	$142,087	$72,128	$14,835	$290,502
Cost/Benefit	**$0.56**	**$1.33**	**$1.15**	**$11.77**	**$5.25**	**$1.48**
Average						
Harvest	3,266	13,069	41,471	2,548	803	61,157
Catch	43,581	27,198	117,477	7,139	2,498	197,892
Stocking Cost	19,152	65,202	176,362	135,011	7,418	$403,143
Cost/Benefit	**$0.41**	**$1.62**	**$1.11**	**$13.94**	**$2.25**	**$1.56**

[a] Lake trout were not stocked in 1993 but fish were harvested in 1993 from previous stockings.

stocking costs and effort was very apparent in 1992 when stocking costs hit a historical high and effort was the lowest since 1986. This combination resulted in a record high CDF. While we can account for the high stocking cost, we can not determine the cause for the large decrease in fishing effort in 1992. Although we can manipulate stocking costs, our influence on anglers and their decision to participate in a fishery is usually indirect and limited to factors that we can control. Some of these factors include improving public access to fishing locations, informing anglers of various and unique fishing opportunities, and managing our fisheries to provide an attractive incentive to go fishing.

Hatchery Operation Costs and Fish Production

Stocking cost and in turn CDF are dependent on the cost of producing fish and the quantity of fish produced. Low costs and high production yield the lowest cost per kilogram of fish produced. In CY94, about one third of operational cost for Clear Hatchery ($152,000) was dedicated to the production of Arctic grayling (5,741 kg) for stocking into the Chena River. Although producing these fish was part of the hatchery's operation, the incurred costs were not considered part of the stocked waters program that year. Production of Arctic grayling for the Chena River ended after CY94, and fish production declined in CY95; however, hatchery operational costs remained similar to that for CY94. As a result, the cost per kilogram of fish produced at Clear Hatchery increased from about $26 in CY94 to about $44 in CY95. Better planning between hatchery managers and fishery managers can take advantage of empty hatchery space and maintain higher production levels which help keep the cost per kilogram down. However, production should be increased only if there is a need for additional fish.

The decline in effort in CY94 and the subsequent reduction in CDF that year probably were not due to fewer fish being stocked because fish available for harvesting in CY94 had been stocked in prior years.

Stocking costs increased again in CY95 in part because we stocked more fish than we originally planned. Hatcheries produced extra fish because survival was higher than expected and some projects were not implemented even though fish were produced. These circumstances resulted in lower costs per fish but stocking costs for some locations were much higher than planned because additional fish were stocked.

Management Objectives

While we did not anticipate meeting these objectives in just one or two years, it does not seem possible to meet all objectives for all locations unless effort increases beyond the historical high levels attained prior to CY91. None of the management objectives were achieved for any of the fisheries in CY92, only two were achieved in CY93, and two were achieved in CY94. Quartz Lake was the only location for which fishery statistics for CY93 were close to all of its objectives. Although fisheries at the small lakes exceeded their objective for effort in CY94 and CY95, the estimated CDF was much higher than the objective. Changes made to the overall stocking program did result in lower stocking costs in CY93 and CY94. However, any hope of achieving more of the management objectives in CY94 was eliminated by relatively low effort. Higher stocking costs in CY95 will further widen the gap between fishery statistics and fishery objectives. Only a dramatic increase in effort will improve the situation.

Although it is difficult to establish a cause and effect between stocking methods and fishing effort, we may reasonably expect effort to increase in the future and should manage the stocking program to meet angler demand while minimizing costs. Some examples of reducing stocking costs while maintaining or improving fisheries are: 1) stocking fingerling rainbow trout in Quartz Lake and subcatchable rainbow trout in Birch Lake; and, 2) multiple stockings of catchable rainbow trout in urban ponds. Although cost per fish for stocking at Birch Lake was less for fingerlings, cost-per-survivor to a catchable size was less for fish stocked as subcatchables. Apparently, in Birch Lake the higher rate of survival for subcatchables offset their higher stocking cost. Wiley et al. (1993) found similar results for the cost of stocked fish returned to the creel in Wyoming. The small urban ponds are close to Fairbanks and North Pole which makes them easily accessible for a large number of anglers. As a result we think these lakes receive a lot of fishing pressure for their size and are probably quickly fished out. Havens et al. (1995) recommends similar stocking methods for lakes along the roadside in south-central Alaska. Stocking more fingerling-size fish is not a workable option because small ponds and lakes probably can not produce or sustain sufficient numbers of catchable rainbow trout to meet demand. Nehring (no date) reports a similar situation for some Colorado streams where the production of quality size rainbow trout and brown trout is limited by environmental constraints. For these reasons, we plan to stock catchable size fish in these ponds two or more times during spring and summer to provide better fisheries close to town. Although stocking cost for these ponds will increase, we expect the cost-to-the-creel and CDF will decrease. Of course, to reduce stocking costs we can also drastically reduce the number and size of fish that are stocked. But we risk losing fishing effort because anglers may no longer be drawn to smaller fish populations. While the stocking program was modified to lower costs, it also was our intent to make the fisheries on stocked game fish more attractive to anglers. These changes should result in increased effort and harvest.

Changing one factor in the stocking program affects the other factors in ways that can be either positive or negative. A method to investigate the relation between these various factors is through systems analysis where the various factors in the stocking program and how these factors function individually and collectively are modeled. By assigning values and constraints to these factors we can examine the effect of change to determine which factors have the most effect. Also, we can determine the most parsimonious combination of values for the factors. A parsimonious solution will provide an acceptable level of benefits for an acceptable cost. This is a method of balancing costs and benefits when we want to keep stocking costs at a minimum but at the same time maintain a desirable and attractive fishery. Even though this method can provide a best solution for a given situation, it should only be used as a decision making tool and not as the justification for a decision. The fishery manager should use this solution as just one of many pieces of information that are used in the decision making process.

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APPENDIX A

Appendix A.-Date of release, numbers, and size of Arctic char stocking in Harding Lake, 1988-1995.

Date	Number Stocked	Weight (g)
15-Sep-88	5,736	44
15-Sep-88	5,849	44
19-Sep-88	4,771	47
5-Oct-88	3,465	72
5-Oct-88	200	42
1-Nov-88	4,077	53
2-Nov-88	3,262	53
3-Nov-88	3,460	53
6-Feb-89	2,125	122
7-Feb-89	2,112	122
8-Feb-89	2,137	122
9-Feb-89	2,017	122
22-May-89	418	739
23-May-89	418	739
24-May-89	418	739
18-Jul-89	12,635	19
11-Oct-89	8,055	112
12-Oct-89	8,055	112
13-Oct-89	3,100	112
16-Oct-89	9,255	98
17-Oct-89	5,786	98
21-Mar-90	437	653
22-Mar-90	438	653
23-Mar-90	437	653
28-Aug-90	49,900	20
29-Aug-90	20,614	35
31-Aug-90	15,159	35
19-Sep-90	11,230	56
20-Sep-90	7,331	50
29-May-91	1,044	761
30-May-91	522	761
18-Jul-91	49,296	11
19-Jul-91	49,095	11
23-Jul-91	7,659	11
21-Aug-91	22,967	31
22-Aug-91	24,030	34
23-Aug-91	20,452	35
3-Sep-91	22,888	43
4-Sep-91	23,386	42
5-Sep-91	7,992	42
9-Sep-91	29,967	33
10-Sep-91	7,010	35
11-Sep-91	12,684	40
16-Jun-92	60,603	9
17-Jun-92	60,603	9
18-Jun-92	60,000	9
19-Jun-92	8,928	10
23-Jun-92	11,190	9
8-Sep-92	17,836	56
9-Sep-92	16,012	63
10-Sep-92	18,412	56
11-Sep-92	17,627	54
29-Sep-92	17,408	60
30-Sep-92	16,614	64
1-Oct-92	10,692	61
15-Sep-93	7,500	106
16-Sep-93	2,500	106
20-Sep-94	10,000	58
14-Sep-95	9,990	73

APPENDIX B

Appendix B.-Number of days fished (effort) by location, harvest and stocking costs for waters stocked with game fish in the Tanana Valley.

	Number of Days Fished (effort)						Total		
Year	Birch Lake	Quartz Lake	Chena Lake	Harding Lake[a]	PDS[a, b]	Small Lakes[a]	Days Fished	Harvest	Stocking Costs
1977	8,118	6,317				6,442	20,877	13,143	
1978	8,982	6,845				6,204	22,031	28,818	
1979	7,804	10,150				5,227	23,181	41,259	
1980	17,036	13,994				9,796	40,826	45,317	
1981	14,233	19,599				6,348	40,180	81,865	
1982	16,677	18,254				7,583	42,514	69,560	
1983	15,882	14,162				7,048	37,092	54,919	
1984	13,170	15,922	11,044	427		9,247	49,810	63,267	
1985	14,444	16,456	11,288			4,955	47,143	74,474	
1986	9,969	18,486	8,853	516		3,612	41,436	55,331	$274,155
1987	15,375	20,410	9,472	1,281	6,629	8,466	61,633	58,390	$353,060
1988	15,607	19,391	9,404	814	12,188	15,662	73,065	110,687	$434,169
1989	14,284	18,299	16,180	1,234	11,373	14,854	76,224	93,289	$429,868
1990	15,541	19,746	12,875	1,948	13,853	14,686	78,648	78,086	$525,129
1991	13,893	15,478	9,444	2,578	8,852	16,449	66,693	100,783	$579,953
1992	10,072	13,486	6,007	2,534	6,804	10,794	49,697	54,307	$626,232
1993	10,447	17,613	6,668	2,443	8,627	22,516	68,313	72,453	$525,034
1994	9,880	14,031	2,828	2,457	5,685	21,859	56,739	49,733	$292,672

[a] These locations include stocked and wild game fish. The effort for these locations was adjusted to reflect the number of days attributed to stocked game fish only.

[b] PDS = Piledriver Slough.

APPENDIX C

Appendix C.-Operational costs, total weight of fish produced, and cost per kilogram of fish produced at various hatcheries, 1986-1995.

Hatchery	Year	Fiscal Year Operation Cost	Calendar Year Total Weight (kg)	Cost per kg
Clear AFB:	1986	$334,000	7,956	$41.98
	1987	$357,900	9,521	$37.59
	1988	$408,000	8,013	$50.92
	1989	$393,000	13,673	$28.74
	1990	$412,000	5,377	$76.62
	1991	$412,000	14,820	$27.80
	1992	$432,331	15,647	$27.63
	1993	$453,126	16,044	$28.24
	1994	$457,863	17,290	$26.48
	1995	$453,200	10,266	$44.15
Ft. Richardson:	1986	$914,000	36,483	$25.05
	1987	$908,000	13,160	$69.00
	1988	$810,000	43,237	$18.73
	1989	$877,000	58,544	$14.98
	1990	$909,000	60,151	$15.11
	1991	$1,121,000	48,259	$23.23
	1992	$1,203,930	70,502	$17.08
	1993	$1,135,601	55,568	$20.44
	1994	$1,201,619	54,848	$21.91
	1995	$1,197,700	65,150	$18.38
Elmendorf AFB:	1986	$449,000	14,956	$30.02
	1987	$467,000	40,474	$11.54
	1988	$475,000	36,031	$13.18
	1989	$482,000	30,279	$15.92
	1990	$490,000	28,487	$17.20
	1991	$540,000	30,172	$17.90
	1992	$554,808	31,248	$17.75
Big Lake:	1986	$395,000	5,671	$69.65
	1987	$368,000	8,449	$43.56
	1988	$388,000	13,201	$29.39
	1989	$398,000	3,553	$112.03
	1990	$405,000	6,294	$64.34
	1991	$420,000	8,112	$51.78
	1992	$364,935	3,726	$97.94
	1993	$375,344	4,743	$79.14

1995 data are from Clear AFB Hatchery and Ft. Richardson Hatchery. Prior to 1995 data are from Recreational Fishery Program Maintenance of Effort (CFMD 1984-1994).

APPENDIX D

Appendix D.-Stocking costs for major fisheries by species, 1986-1995.

		Year									
Location	Species	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Birch Lake	Arctic Char	$0	$0	$0	$0	$0	$5,708	$24,562	$0	$22,978	$24,143
	Arctic Grayling	$0	$0	$0	$0	$0	$5,482	$5,345	$2,344	$1,843	$3,293
	Chinook Salmon	$0	$0	$0	$0	$0	$0	$0	$17,767	$0	$0
	Rainbow Trout	$69,402	$34,395	$73,296	$30,067	$16,730	$13,380	$12,548	$37,373	$22,751	$44,545
	Coho Salmon	$6,666	$7,293	$6,782	$4,875	$22,759	$2,066	$0	$12,884	$5,204	$37,259
	Total	$76,068	$41,688	$80,078	$34,942	$39,489	$26,636	$42,456	$70,368	$52,777	$109,240
Chena Lake	Arctic Char	$0	$0	$0	$10,326	$0	$38,622	$17,131	$17,962	$7,907	$16,096
	Arctic Grayling	$135	$0	$0	$0	$0	$1,782	$1,492	$1,758	$2,539	$2,470
	Chinook Salmon	$0	$0	$3,733	$0	$0	$0	$0	$7,196	$10,292	$35,703
	Rainbow Trout	$49,400	$26,769	$50,791	$42,836	$47,078	$63,765	$26,038	$26,974	$15,300	$35,080
	Coho Salmon	$4,811	$5,875	$2,589	$1,742	$0	$839	$18,384	$6,590	$1,716	$18,649
	Total	$54,346	$32,644	$57,113	$54,904	$47,078	$105,007	$63,045	$60,480	$37,755	$107,998
Harding Lake	Arctic Char	$0	$0	$51,150	$168,075	$262,698	$242,942	$236,828	$29,937	$15,555	$32,446
	Arctic Grayling	$6,396	$241	$1,072	$0	$12,600	$13,088	$334	$0	$0	$0
	Lake Trout	$0	$0	$0	$0	$25,975	$0	$0	$0	$0	$0
	Sockeye Salmon	$0	$0	$6,226	$6,445	$11,323	$0	$0	$0	$0	$0
	Rainbow Trout	$17,169	$41,415	$15,453	$4,394	$43,634	$26,534	$33,328	$0	$0	$0
	Sheefish	$47,397	$65,750	$458	$3,116	$0	$0	$0	$0	$0	$0
	Total	$70,962	$107,405	$74,360	$182,030	$356,230	$282,565	$270,491	$29,937	$15,555	$32,446
Piledriver Slough	Rainbow Trout	$0	$35,256	$69,055	$45,261	$33,821	$43,029	$85,877	$105,253	$42,985	$93,764
	Total	$0	$35,256	$69,055	$45,261	$33,821	$43,029	$85,877	$105,253	$42,985	$93,764
Quartz Lake	Arctic Char	$0	$0	$0	$0	$0	$21,997	$8,289	$0	$7,960	$12,505
	Chinook Salmon	$0	$0	$0	$0	$0	$0	$0	$17,363	$0	$0
	Rainbow Trout	$21,824	$63,192	$69,298	$39,199	$16,363	$29,097	$23,736	$11,474	$10,512	$7,856
	Coho Salmon	$28,082	$22,131	$25,892	$17,457	$26,060	$7,999	$0	$16,869	$10,554	$47,799
	Total	$49,906	$85,323	$95,190	$56,657	$42,422	$59,093	$32,025	$45,706	$29,026	$68,160

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Location	Species	Year 1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Small Lakes	Arctic Char	$2,258	$676	$4,871	$6,834	$0	$33,850	$80,615	$149,993	$17,727	$39,567
	Arctic Grayling	$1,859	$6,272	$7,133	$2,426	$275	$7,755	$12,980	$17,740	$12,078	$28,226
	Chinook Salmon	$8,150	$13,622	$2,659	$0	$0	$0	$0	$0	$11,558	$14,772
	Lake Trout	$0	$0	$9,080	$25,601	$0	$4,557	$0	$0	$14,835	$0
	Rainbow Trout	$5,539	$15,418	$27,104	$10,095	$302	$14,991	$29,548	$29,565	$50,539	$92,946
	Sheefish	$592	$428	$0	$834	$3,272	$0	$0	$0	$0	$0
	Coho Salmon	$4,417	$11,463	$6,638	$10,285	$2,241	$0	$6,065	$6,742	$5,669	$16,321
	Coho Salmon Triploid	$0	$0	$0	$0	$0	$0	$347	$0	$0	$0
	CohoXChinook Hybrid	$0	$0	$0	$0	$0	$0	$384	$0	$0	$0
	Total	$22,815	$47,879	$57,484	$56,075	$6,090	$61,153	$129,939	$204,040	$112,405	$191,832
	Grand Total	$274,097	$353,060	$433,280	$429,868	$525,129	$577,484	$623,832	$515,784	$290,503	$603,440

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Location	Species	Year 1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
All Lakes	Arctic Char	$2,258	$676	$56,021	$185,236	$262,698	$343,119	$367,426	$197,893	$72,128	$124,756
	Arctic Grayling	$8,390	$9,378	$8,205	$2,426	$12,875	$28,107	$20,151	$21,843	$16,460	$33,989
	Chinook Salmon	$8,150	$13,622	$6,392	$0	$0	$0	$0	$42,326	$21,850	$50,475
	Lake Trout	$0	$0	$9,080	$25,601	$25,975	$4,557	$0	$0	$14,835	$0
	Sockeye Salmon	$0	$0	$6,226	$6,445	$11,323	$0	$0	$0	$0	$0
	Rainbow Trout	$163,334	$216,446	$304,998	$171,852	$157,927	$190,796	$211,075	$210,637	$142,087	$274,192
	Sheefish	$47,989	$66,178	$458	$3,949	$3,272	$0	$0	$0	$0	$0
	Coho Salmon	$43,975	$46,762	$41,901	$34,359	$51,059	$10,904	$24,449	$43,085	$23,142	$120,027
	Coho Salmon triploid	$0	$0	$0	$0	$0	$0	$347	$0	$0	$0
	Coho x Chinook hybrid	$0	$0	$0	$0	$0	$0	$384	$0	$0	$0
	Grand Total	$274,097	$353,060	$433,280	$429,868	$525,129	$577,484	$623,832	$515,784	$290,503	$603,440

APPENDIX E

Appendix E.-Archive files for data collected during investigations of visual implant tag loss in rainbow trout and Arctic char reproduction in Harding Lake.

File Name	Description
RT_VIT95.XLS	Data file of visual implant tag loss for rainbow trout at Ft. Richardson hatchery, 1995.
U1890LC5.DTA	Data file of catches by species, location, depth, gear type, and biological information for fish captured in Harding Lake, 1995.

Data files are available from the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage, Alaska, 99518-1599.